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(54) **Improved method of signalling supervisory information in digital line transmission systems**

(57) In a line transmission system supervisory information is required in addition to digital information. Normally a separate transmission channel is required to transmit this information. The coding system of this proposal removes the requirement for an additional signalling channel. The method used requires that the line transmission coding employed should have more combinations than the coding of the data to be used (i.e. (2N-1) B→2NB). For example in optical fibre transmission systems it is usual to use line codes such as 3B 4B. In such a coding system there are 14 zero or 1 bit disparity codes which are available for mapping onto the eight "tri-bit" combinations of the data to be transmitted. Accordingly four illegal (i.e. unused) code combinations exist. Selective use of a pair of these illegal codes for the same pair of tri-bit combinations can be used to send a one bit supervisory signal.

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SPECIFICATION

Improved method of signalling supervisory information in digital line transmission systems

5   The present invention relates to digital line transmission systems and is more particularly concerned with a method of encoding and decoding a digital signal for transmission so that the coder/decoder not
10   only matches the signal to the transmission medium but also directly provides information on the performance of the link (error rate and reframe information being indicated with no additional circuitry).

In a line transmission system supervisory informa-
15   tion is required as well as transmission of the main digital signal. This is to automatically signal the status of various critical system functions such as error rate etc. Normally a separate transmission path is required to transmit this information. The present
20   invention removes the requirement for an additional signal path or an increase in digit rate whilst allowing the transmission of network control information such as error rate and engineering order wire.

According to the invention there is provided a
25   method of handling supervisory information in a digital line transmission system including a transmitter and a receiver, the line transmission system handling a digital information stream formed by a succession of binary information bytes and using a
30   line coding code conversion process in which each information byte is encoded into a line transmission byte which contains more binary bits than the corresponding information byte and in which the transmitter includes means for controlling the code
35   conversion process for selected information bytes to generate amended line transmission bytes which indicate the state of a supervisory signal in addition to the selected information byte and the receiver includes means for decoding the amended line
40   transmission bytes and for indicating the state of the supervisory signal in addition to the selected information byte.

The method requires that the coding used should have sufficient illegal (or unused) combinations in
45   the line code to enable use to be made of them in transmitting the additional two state supervisory information. The invention is particularly applicable (but not limited) to transmission over optical fibres where line code conversion to codes of the form
50   $(2n-1)B/2nB$ (where $n>1$) are used.

An example will now be given using 3B/4B code conversion i.e. 3 binary digit information bytes which are replaced by 4 binary digit line transmission bytes.
55   The incoming binary data and signal is first scrambled to ensure that the required 'tri-bits' (i.e. groups of 3 bits) all occur with sufficient frequency for the supervisory signal to be carried. The resulting data stream is then coded for transmission to line
60   using the following encoding table:—

IB(3B)	LTB(4B)	Disparity	Supervisory Signal
	0000 illegal word	−2	
000	0001	−1	
111	0010	−1	
001	0011	0	
	0100 illegal word	−1	
010	0101	0	
(011	0110	0	1
(011	0111*)	+1	0
(	) were		
(100	1000*) illegal	−1	0
(100	1001	0	1
101	1010	0	
	1011 illegal word	+1	
110	1100	0	
000	1101	+1	
111	1110	+1	
	1111 illegal word	+2	

The 4 bit line transmission bytes starred were so-called 'illegal' i.e. unused bytes. By using two of the otherwise unused 4 bit output bytes as illustrated
85   above supervisory and order wire information may be transmitted as follows with no effect on the main data path:—

(a) when a supervisory signal "1" is to be transmitted
90   011 is encoded as 0110
and 100 is encoded as 1001
(b) when a supervisory signal "0" is to be transmitted
011 is encoded as 0111
95   and 100 is encoded as 1000

The coding changes are detected by the decoder at the receive end of the system and easily separated as a lower speed digital data path independent of the main data signal.
100   The alternative method of incorporating a supervisory signal is to increase the bit rate of the main data signal and using a multiplexor to introduce the supervisory.

Where line coding has to be introduced for other
105   reasons e.g. $(2n-1)B \rightarrow 2nB$ coding the proposed method requires no increase in bit rate.

CLAIMS

1.   A method of handling supervisory information in a digital line transmission system including a

transmitter and a receiver, the line transmission
system handling a digital information stream formed
by a succession of binary information bytes and
using a line coding code conversion process in
5 which each information byte is encoded into a line
transmission byte which contains more binary bits
than the corresponding information byte and in
which the transmitter includes means for controlling
the code conversion process for selected informa-
10 tion bytes to generate amended line transmission
bytes which indicate the state of a supervisory signal
in addition to the selected information byte and the
receiver includes means for decoding the amended
line transmission bytes and for indicating the state of
15 the supervisory signal in addition to the selected
information byte.

2. A method of handling supervisory information
in a digital line transmission system according to
claim 1 in which the line coding code conversion
20 process uses a code of the form (2n-1)B/2nB (where
n>1).

3. A method of handling supervisory information
in a digital line transmission system according to
claim 2 in which at least one of the information bytes
25 is allocated two line transmission bytes arranged to
be selected for transmission in accordance with the 1
or 0 state of the supervisory signal when the one
information byte is to be transmitted.

4. A method of handling supervisory information
30 in a digital line transmission system substantially as
herein before described.

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